TWO YEAR EVALUATION OF CORRECTIVE MEASURES IMPLEMENTATION MERCK & CO. , INC., WEST POINT SITE WEST POINT, PA

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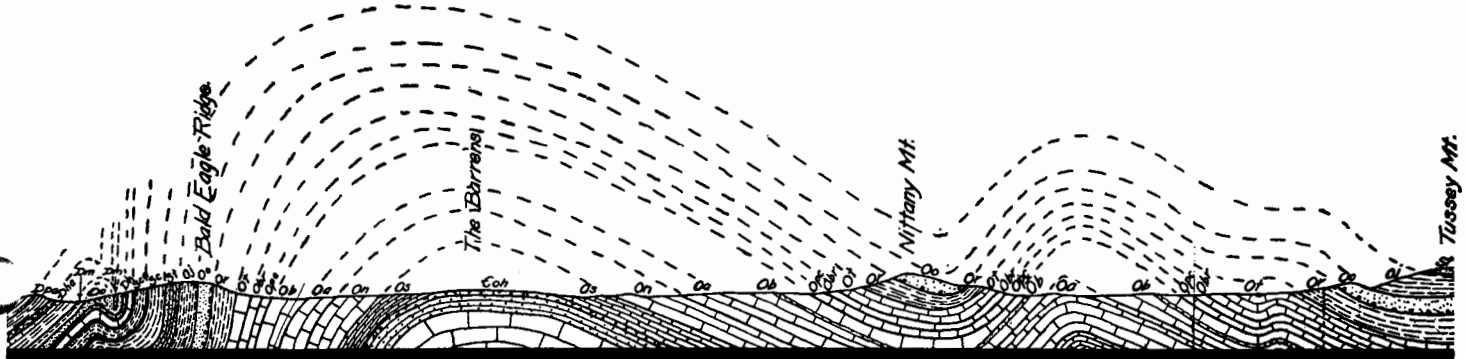

NITTANY GEOSCIENCE INC.

120 RADNOR ROAD
STATE COLLEGE
PENNSYLVANIA 16801

TWO YEAR EVALUATION OF CORRECTIVE MEASURES IMPLEMENTATION MERCK & CO., INC., WEST POINT SITE

Prepared for:

Merck & Co., Inc.
West Point, Pennsylvania.

Prepared by:

Nittany Geoscience, Inc.
State College, Pennsylvania

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1.0 INTRODUCTION

1.1 Summary of Goals

The goal of this performance report is to present the progress and performance of active remediation technologies at the West Point site and summarize results of the CM optimization and performance studies. These studies include the ISV system optimization pilot study, the PW12 and PW13 groundwater extraction well optimization study, production well concentration rebound study, and non-CM monitoring well and piezometer sampling.

As described in the *Corrective Measures Implementation Work Plan* (CMI Work Plan), Merck & Co., Inc., 1995, Merck may petition EPA to alter the chosen remedial measures, groundwater sampling frequency, and location and number of points of compliance. Merck has evaluated these CMI components based on analysis of contaminant concentration data, hydrogeologic conditions, and current regulatory requirements. This thorough evaluation has resulted in scientifically-based evidence supporting the elimination or modification of certain components of the CMI. Concurrent with the submittal of this performance report, Merck is requesting EPA-approval to the following proposed CMI modifications, which are further discussed herein:

- Closure of ISV Units 5 & 8
- Reduction in the groundwater monitoring frequency
- Modification of Phase III abandonment wells
- Removal of well N12 from monitoring program
- Removal of 3 analytes (trans-1,2-dichloroethene, vinyl chloride, and trichlorofluoromethane) from the listing of 12 VOCs currently monitored.

1.2 Summary of Results

Merck's implementation of corrective measures began in 1985, ten years prior to the CMI, as initially documented in the *Phase I Report of Hydrogeologic Studies at the West Point Plant*, (Nittany Geoscience, March 1988). Consequently, the history and operational experience with these corrective measures extends well beyond the two year history of the CM covered by this performance evaluation, to

approximately 50 years for the production well system. There is a similarly long history of water quality monitoring and hydrogeologic investigation of the site. Ten years of groundwater monitoring results confirm that the distribution of site related constituents in groundwater is stable and predictable. This monitoring also confirms that potable water supplies drawn from groundwater for use by the West Point Plant and by its neighbors are meeting federal drinking water standards for contaminants of concern at the facility. The two remaining ISV systems have had no measurable effect on contaminant concentrations in groundwater and no consequence with respect to risk. This is evidenced by data from 10 years of operation at ISV Unit 5 and 4.5 years of operation at ISV Unit 8. Continued operation of these systems is therefore unwarranted.

The results of this performance evaluation confirm and amplify conclusions drawn from direct experience regarding the relative efficacy of various CM elements (*Corrective Measures Study, Phase III Report for the Hydrogeologic Investigation at the West Point Site*, Nittany Geoscience, July 1993). In particular, continuous operation of the production well system was a basis for the *Site Wide Risk Assessment* (Environmental Standards, Inc., November 1992) finding that the site poses no unacceptable risk.

The results of this evaluation further indicate that certain components of the CM can be modified without a reduction of CM efficacy. The results of the performance evaluation for each component of the CM and proposed modifications are summarized below:

- **Pump-and-treat system** - Having demonstrated its remedial effectiveness, the pump-and-treat system will remain in operation, with no proposed modifications at this time. Hydraulic control of the plume continues to be maintained as verified by sampling of residential wells and monitoring wells. Furthermore, the concentrations of all site-related contaminants in residential wells remain below the media cleanup standards specified in the Final Decision and Response to Comments (FDRTC). It is recognized that the capture zone of the pump-and-treat system will further be enhanced by the EPA-approved addition of production wells 14 and 15 and deepening of PW11.
- **ISV systems** - Operations of ISV Units 5 and 8 were optimized as a result of pilot testing specified in the FDRTC. Despite this optimization, the units have demonstrated a lack of influence on contaminant concentrations in the saturated zone of the bedrock aquifer, which is the only pathway for off-site migration. This pathway is being

effectively controlled and remediated by the production well system. Continued ISV operation is an impracticable method for achieving media cleanup standards established by FDRTC, which are based on groundwater concentrations at points of compliance that have not been measurably affected by past ISV operations. Therefore, continued operation of the ISV units is unnecessary for the protection of human health and the environment. Pending EPA approval, ISV Units 5 and 8 will be closed and properly abandoned.

- **Shallow groundwater** - The shallow groundwater system treats groundwater collected from sumps at Buildings 45 (NSSX) and 78 (NSS2A), and from two ISV vents at ISV Unit 5 (wells C4 and C7). The system was installed to improve ISV operation by dewatering the shallow groundwater zone and removing water entrained in the influent vapor stream. Therefore, pending EPA approval of the closure of ISV Unit 5, groundwater will no longer be collected from these wells. However, operation of the shallow groundwater treatment system will be continued for water collected from the building sumps.

- **Groundwater monitoring** - Groundwater monitoring has been conducted as specified in the FDRTC and the CMI Work Plan. The groundwater monitoring program has effectively measured the progress of the CM and demonstrated the achievement of its objectives. Pending EPA approval, CM sampling for 9 VOCs at monitoring wells and production wells will be conducted at two-year intervals (every other March), with results to be reported in concurrence with the biannual submission of performance reports. Sampling of the seven remaining residential wells and data validation will continue on a quarterly basis. Weekly monitoring of the potable water carbon system will continue to be conducted to ensure the water quality of potable supplies is maintained. Conducting biannual compliance monitoring of production and monitoring wells will streamline the monitoring program and reduce the scale of reporting without compromising the effectiveness of remediation or protection of human health and the environment.

- **Landfill maintenance** - Requirements of the FDRTC regarding the landfill have been maintained. The landfill remains non-operational and its soil cap has been maintained as a barrier to physical contact with buried waste material. Hydraulic control of groundwater within the landfill area has been maintained by the production well system and augmented by the addition of production well 13. As such, wells LF-2 and LF-3 were previously approved for abandonment by the Pennsylvania DEP. The landfill will remain closed, with no proposed modifications at this time.

- **Site restoration** - Phase III Abandonment was previously approved by the EPA. Based on results of the January 1997 sampling of non-CM piezometers and monitoring wells, additional non-essential wells have

been identified. Pending EPA approval, the Phase III well abandonment plans will be modified to include these additional non-essential, non-residential wells.

2.0 PUMP-AND-TREAT SYSTEM PERFORMANCE

Production well and monitoring well sampling data indicate that the production well system is meeting its two primary objectives under the CMI: contaminant recovery and hydraulic control of the groundwater contaminant plume. Hydraulic control has kept the outer margins of the chloroform plume in an essentially static position, which is indicative of complete containment. The production well system also has generally reduced or held static chloroform concentrations in CM monitoring wells and residential wells over the two years of the CMI and the preceding two years of interim sampling. Recent sampling data from non-CMI monitoring wells shows a similar pattern of reduced chloroform concentrations. Furthermore, a review of data since the implementation of interim sampling four years ago confirmed that the concentrations of all site-related contaminants in residential wells continue to be maintained below Maximum Concentration Levels (MCLs) and Risk-Based Concentrations (RBCs).

The effectiveness of pump-and-treat technology is further demonstrated by influence of two production wells (PW12 and PW13) added to the system in 1995. These wells caused a shifting of capture zones at the site and enhanced hydraulic control. A production well rebound study conducted from December 1995 to April 1997 further demonstrates that production wells have the capacity to significantly diminish or remove residual chloroform from principal water bearing zones in their vicinity. This process is sufficiently advanced at the older plant production wells, such as PW9 and PW2, where chloroform concentrations in the vicinity of these wells decrease rather than rebound when the wells are not pumped. The analytical results from this concentration rebound study are presented in Table 1 and detailed in Section 2.3 of this report.

2.1 System Operation and Modifications

The site currently extracts approximately 1 million gallons of groundwater per day for use as plant production and potable water subsequent to treatment with granular activated carbon (GAC) beds. To ensure the quality of process and potable water supplies, constituent concentrations in the water are measured each week at three points in the treatment process: influent, intermediate (between carbon beds),

and effluent, in accordance with the "Sampling and Analysis Plan: Potable Ground Water Treatment System" (Appendix D of the CMI Work Plan). This weekly monitoring is conducted independent of the quarterly CM sampling of individual production wells. In addition to weekly monitoring, new extraction locations provide continued assurance of the pump-and-treat system's effectiveness.

Nine production wells (Figure 1) at the West Point site are permitted to withdrawal up to 40 million gallons of groundwater in a 30-day period from the lower bedrock aquifer (LBA), by the Delaware River Basin Commission (DRBC). Approval by the DRBC of the allocation increase from the previous limit of 25 million gallons/30 days took place in April 1995. Production wells 12 and 13 were added to the system and brought on line in May 1995. As previously approved by the EPA, Merck is currently in the process of installing two additional production wells (PW14 and PW15) to the system and deepening PW11, which will further enhance contaminant recovery.

2.2 Contaminant Recovery

During the first two-year period of the CMI under evaluation, the production well system recovered chloroform from the LBA at an average mass rate of about 54 pounds per month. The mass of chloroform removed from the aquifer was 712 pounds in 1995, and 587 pounds in 1996. Chloroform recovery data are tabulated for the years 1994 through 1997 on a monthly basis in Appendix A.

A direct beneficial effect of chloroform recovery by the production well system is demonstrated by chloroform concentration trends at site monitoring locations. Concentration data have been evaluated from the CMI quarterly groundwater monitoring and from the January 1997 sampling of non-CMI monitoring wells. Trend plots of the CMI quarterly groundwater monitoring results are presented in Appendix B. These data confirm that groundwater chloroform concentrations generally have remained static or have decreased in monitoring wells and residential wells. This overall reduction in chloroform concentrations at site monitoring locations corresponds to a reduction in the mass of dissolved chloroform in the aquifer. The beneficial effect of the chloroform mass reduction and hydraulic control is also illustrated by the numbers of groundwater samples collected during the past four years which were below the media cleanup standard specified in the FDRTC (tabulated in Appendix C). Review of the past four years of data shows

that most of the monitoring wells and all of the residential wells have been below the chloroform cleanup standard at all times. TCE concentrations cannot be similarly evaluated because increasing trends at site monitoring locations are the result of a drawing in of TCE from an off-site source(s).

The addition of production wells PW12 and 13 has added to the contaminant recovery capability of the pump-and-treat system. A groundwater extraction well optimization study of these wells was conducted by Woodward-Clyde Consultants in December 1995. The study consisted of packer testing of selected intervals of PW12 and PW13, and examination of geologic and video logs. The objective of the project was to evaluate the operation of the two production wells to maximize contaminant recovery and optimize well yield. The results of this study indicated that the source of the majority of the chloroform detected in the wells is from above 250 feet in each well and that there is little risk of vertical contaminant transport in either well. Results of the groundwater extraction well optimization study are summarized as follows.

- Packer testing indicated that most of the groundwater yield from PW12 occurred above 250 feet bgs and was generally equivalent to the sustainable yield of the well. Based upon the geophysical testing, it is likely that a major fraction of the water entering the well originates in the open fracture zone observed at approximately 200 feet bgs. In addition, results of the geophysical testing and video logging indicate that the lower section of the well (with few significant fractures below 325 feet bgs) is poorly connected to the deep aquifer and does not pose a significant risk in terms of vertical contaminant transport.
- Based upon the packer testing, the loading of volatile organic compounds during the three tests at PW13 remained similar for each zone tested, suggesting that a majority of the constituents in the discharge were entering the well above the highest packer setting (250 feet). Since the well will be in continuous production, it is highly unlikely that migration of constituents would occur between different levels in the wells.

It should be noted that observations of the depths of water bearing zones made during the drilling of these two wells are consistent with the conclusions of the optimization study. The conclusion that downward vertical migration of contaminants is unlikely is also consistent with 300-foot monitoring well sampling results that show either an absence of chloroform contamination or steadily declining concentrations to 300 feet depth in the LBA. This trend is clearly

illustrated by chloroform isoconcentration cross sections submitted in the *Phase II Final Report, Hydrogeologic Investigation at the West Point Site* (Nittany Geoscience, November 1992). Minor levels of chloroform were detected in one 300-foot monitoring well, N34D, in 1997 non-CMI well sampling; earlier sampling showed steadily declining concentrations in N34D after pumping of nearby production well PW9 began in 1990 (Figure 7). From this it can be concluded that the operation of 300 to 600 foot deep production wells at the site for the past 20 to 50 years has not promoted downward migration of chloroform to deeper portions of the LBA. To the contrary, the principal effect of production well operation has been to remove residual chloroform from water bearing zones that supply the wells, regardless of their depth.

2.3 Plume Containment

Plume containment is important to meet the CMI objective to eliminate or minimize, to the extent practical, potential threats to human health and to the environment. To this end, the pump-and-treat system at the West Point site has maintained a hydraulic barrier between on-site sources of contamination, and domestic and public water-supply wells that surround the site. Plume containment was enhanced during the first two-year period of the CMI by the installation of production wells PW12 and PW13, the abandonment of North Wales Water Authority (NWWA) well 23 in September 1994, and the discontinuance of NWWA well 7 in September 1995 (and its subsequent abandonment in 1997). The future addition of production wells PW14 and PW15 to the system and deepening of PW11 to 300 feet will further enhance hydraulic control of the contaminant plume.

CM Monitoring Data

Hydraulic control of the contaminant plume is demonstrated by site water level monitoring and contaminant concentration data from CMI quarterly monitoring locations. The extent of the chloroform contaminant plume as represented in quarterly maps has remained consistent throughout the CMI. Over the same period, chloroform concentrations generally have remained static or have decreased in CM monitoring wells and residential wells.

Chloroform and TCE concentrations measured at groundwater monitoring locations provide evidence that plume containment has eliminated potential threats to human health and the environment. As shown in the tables in Appendix C, there

were no exceedances of media cleanup standards at any residential well except for TCE at Well R107. It should be noted that R107 was not in use by its owner as a potable water source and was abandoned in February 1997. Quarterly TCE isoconcentration maps clearly identify the source of the low concentrations in R107 to have been unrelated to the Merck site.

The addition of production wells PW12 and PW13 to the production well system in May 1995 has increased the hydraulic influence of the system in the vicinity of the site. The addition of PW12 has increased the rate of southward migration of the TCE plume from off-site sources toward the center of the site during 1995 and 1996. PW12 has also caused an increase in the chloroform concentrations at PW2 (Figure 2) and a decrease in the chloroform concentrations at PW8 (from 270 µg/l to 130 µg/l in the first quarter of 1995). These changes are a result of capture zones of PW2 and PW8 having shifted to accommodate the capture zone of PW12. The zone of influence of PW12, measured in a 48 hour pumping test of that well in February 1994 (*Results and Analyses, February 1994 Pumping Tests of Production Wells 12 and 13*, Nittany Geoscience, April 1994), extends in the direction of bedding strike northeast to the vicinity of Sumneytown Pike and southwest to the vicinity of PW8 (Figure 1). PW2 also has increased competition from PW12 for deeper groundwater having lower chloroform concentrations. The effect of this is a higher average chloroform concentration in PW2. The extraction well optimization study (Woodward-Clyde, 1995) concluded that PW12 obtains most of its flow from fractures at depths of 200 and 300 feet.

The increased hydraulic influence of the production well system is further illustrated by the decrease of chloroform concentrations in production wells PW1 and PW3 since production wells PW12 and PW13 began operating in May 1995. This decrease is attributed in part to the capture by PW13 of contaminated groundwater previously pumped by PW1 and PW3, including a portion of the contaminated groundwater in the vicinity of ISV Unit 5. The zone of influence of PW13, measured in a 48 hour pumping test of that well in February 1994 (*Results and Analyses, February 1994 Pumping Tests of Production Wells 12 and 13*, Nittany Geoscience, April 1994), extends in the direction of bedding strike northeast to the vicinity of N32D (Figure 3). The groundwater capture zones of PW1 and PW3 have therefore shifted to include areas with lower contaminant concentrations.

The pumping of PW13 has also caused an increase of the chloroform concentration at landfill monitoring well LF-1 from approximately 2.5 to 1500 µg/l, which was detected during the non-CMI groundwater sampling event in January 1997. Evaluation of hydrogeologic patterns indicates that the source of this increased chloroform concentration at LF-1 is Source Area 5 rather than the landfill. To illustrate this phenomenon, Figures 4 and 5 show map and cross-section views of chloroform concentrations in the vicinity of the landfill during 1992 (adapted from *Potential Source Area 11 Landfill (closed) Investigation Report*, Nittany Geoscience, November 1992), prior to the installation of PW13. These figures illustrate a southwestward migration of chloroform from Source Area 5 at a depth of 50 to 85 feet bgs. At that time, chloroform concentrations detected beneath Source Area 5 were as high as 1,000,000 µg/l (*Potential Source Area Investigation Report, Merck & Co. Inc.*, Nittany Geoscience, August 1992), but were below 10 µg/l in LF-1. The contrast of chloroform concentrations in PW13 (77 µg/l) and LF-1 (1,500 µg/l) is attributable to the fact that PW13 derives only 15 to 20 gpm of its maximum 120 gpm discharge from the 81 to 100 foot depth range (*Production Wells 12 and 13 Drilling, Merck & Co., Inc.*, Nittany Geoscience, March 1994). Therefore, the shallow source of contamination is diluted by approximately 100 gpm of relatively uncontaminated groundwater from the 216 to 450 foot depth interval. The dilution is predicted to reduce chloroform concentrations by approximately one order of magnitude. The sampled interval in LF-1 is between 85 and 100 feet bgs, near the depth of the highly contaminated zone identified below Source Area 5 and similar to the depth of a water-bearing zone identified during the drilling of PW13 (10-15 gpm at 82-83 feet bgs). The arrow pictured in Figure 4 illustrates the effects of the operation of PW13, which is interpreted to have pulled the chloroform plume back along bedrock strike through the vicinity of monitoring well LF-1. Hence, the increase in chloroform concentration is evidence of the degree of hydraulic control effected by PW13.

Concentration Rebound Study

Merck completed a concentration rebound study to further evaluate the effect of the production well system on groundwater concentrations in the LBA. This study, which was completed in April 1997, had the objective of measuring the change of chloroform concentrations effected by varying periods of production well shut-down. The design of the experiment was to shut down a production well for 30 days. The well was sampled just prior to shut down, 7 days following shut down, and 30 days

following shut down. Three well volumes were purged prior to sampling to ensure a representative sample. Replicate samples were taken to account for variability that may result from sampling with a high capacity production pump. Wells PW2, PW9, PW12 and PW 13 were selected for the study because each is located in a source area.

Results of the study show that chloroform concentrations uniformly decreased through the period of shut down at production wells PW2 and PW9 (Table 1). At PW13 chloroform concentrations rose sharply in the first week and then declined after 30 days, but remained significantly higher than concentrations prior to shutdown. PW12 behaved similarly, except that chloroform concentrations continued to rise between the 7 day and 30 day samples.

These results indicate that production wells, such as PW2 and PW9, that have been in operation for many years have succeeded in removing much of the residual chloroform from their principal water producing zones in the aquifer. Upon well shut down, these productive intervals are therefore preferentially recharged by groundwater having relatively low chloroform concentrations. The continued drop of concentration between the 7 and 30-day sampling reflects additional dilution from slower flow induced by the ambient gradient or by other site production wells. This is not the case at production wells PW12 and PW13, which have been in operation for less than two years. There, sufficient residual chloroform resides in the productive intervals of the aquifer near the production wells to have caused a sharp rise in concentration after 7 days. This rise is attributed to desorption or solution of chloroform resulting from the greater contact time available to groundwater when the well is not pumping. The moderate decline of concentrations between the 7 and 30-day sampling at PW13 reflects the migration of groundwater away from the well induced by the ambient gradient or by other site production wells.

The production well rebound study caused a one-time increase of chloroform concentrations to occur in several production wells and monitoring wells between the December 1996 and March 1997 sampling events. The increases occurred in CM monitoring wells 11-85 and N16, and in production wells PW8, PW9, PW11, PW12, and PW13 (Appendix C). The increases were caused by a temporary shift in capture zone of the well network. As demonstrated in the March 1997 isoconcentration maps, the contaminant plume continues to be contained.

3.0 ISV SYSTEMS PERFORMANCE

ISV Units 5 and 8 were installed in source areas and brought into operation in May 1988 and November 1992, respectively. The locations of ISV Units 5 and 8 are shown in Figure 3. Their purpose has been to remove contaminants residing in the unsaturated bedrock within the shallow groundwater zone (SGZ). Since July 1996, the ISV units have been operated in accord with an optimized schedule based on a pilot study submitted to, and approved by, the EPA in June 1996. Through this time and most of their history, they have recovered chloroform vapors at a rate reduced to an asymptotic limit imposed by the rate of diffusion through fractured bedrock.

All evidence of groundwater sampling indicates that the operation of ISV Units 5 and 8 has not, and will not measurably affect chloroform concentrations in the LBA, which is the only pathway for off-site migration. This pathway is being cost-effectively controlled and remediated by the production well system. Analysis of groundwater elevation contour maps, such as that shown in Figure 3, demonstrate that Unit 5 is predominantly within the capture zone of nearby extraction well PW03 and that Unit 8 is presently within the capture zone of nearby extraction well PW13. Sampling of groundwater from Vent C4 in ISV Unit 5 further indicates that chloroform concentrations SGZ directly beneath Unit 5 are the same as they were when sampled in 1991. Similarly, ISV Unit 8 has been ineffective in the prevention of chloroform migration from Source Area 5 into the LBA. Despite its having been operated for the past 4.5 years, ISV Unit 8 has failed to recover chloroform entering the LBA from Source Area 5; PW13 serves as the primary CM for chloroform removal in the area of ISV Unit 8.

Continued ISV operation is an impracticable method for achieving media cleanup standards established by FDRTC, which are based on groundwater concentrations at points of compliance that have not been measurably affected by past ISV operations. Therefore, continued operation of the ISV units is unnecessary for the protection of human health and the environment. Pending EPA approval, ISV Units 5 and 8 will be closed and properly abandoned.

3.1 System Operation and Modifications

Operation and performance data confirm that the ISV system has been operated according to the requirements of the FDRTC and the scheme set out in the CMI

Work Plan. The FDRTC requires the operation of ISV Units 5 and 8 on a staggered, 20 percent operational schedule for a period of two years. This schedule is designed to evaluate recovery rates by allowing for greater volatilization of contaminants. A two year pilot study was completed to determine the effectiveness of the system and most efficient operational schedule. During the first phase of the pilot study ISV Units 5 and 8 were operated on an experimental series of schedules for a 45-week period.

ISV units were operated three times on each of the following schedules during the 45 week initial phase of the pilot study.

Schedule	1995	1996
4 days off, 1 day on	Jun. 2, Sep. 15	Jan. 5
8 days off, 2 days on	Jun. 15-16, Sep. 28-29	Jan. 18-19
12 days off, 3 days on	Jul. 5-7, Oct. 18-20	Feb. 7-9
16 days off, 4 days on	Aug. 1-4, Nov. 14-17	Mar. 5-8

Chloroform mass recovery results from pilot testing of Units 5 and 8 showed that the eight-day off, two-day on schedule of operation provided the highest mass recovery rate. This schedule of operation was approved by the EPA and implemented in June 1996 (*Evaluation and Pilot Testing, ISV Units 5 and 8*, Nittany Geoscience, June 1996).

3.2 Contaminant Recovery

As stated in the CMI Work Plan, the two ISV units are designed to assist in removing VOCs before they reach the aquifer. During pilot testing the optimal schedule yielded an estimated average chloroform recovery of approximately 17 pounds per day at Unit 5 and approximately 3 pounds per day at Unit 8. When extrapolated to a 24-hour basis the estimated average recovery rate is approximately 27 pounds per day at Unit 5 and 4 pounds per day at Unit 8, which is the highest of

the tested schedules of operation. These recovery rates are expected to gradually decline to a lower level than those experienced during the pilot testing.

Since implementation of the eight-day off, two-day on schedule of operation on a continuous basis in July 1996, the recovery rate of chloroform averaged 15.6 pounds per day of operation at Unit 5 and 3.6 pounds per day of operation at Unit 8. The mass of chloroform removed from the shallow groundwater zone (SGZ) was 887 pounds in 1995, and 929 pounds in 1996. Monthly chloroform mass recovery rates by ISV Units 5 and 8 are tabulated in the Appendix A.

3.3 Closure Rationale

The most direct measure of the technical practicability of the ISV system is the influence of its continued operation on chloroform concentrations in groundwater. It was on this basis that closure of ISV Unit 2 was previously approved by the EPA. By this same measure, current ISV operations have been, and can be expected to remain ineffective.

An analysis of historical sampling results from nearby PW3 provides factual evidence of the lack of influence of ISV operations on the concentration of chloroform in LBA groundwater. Effective mass reduction by ISV Unit 5 or ISV Unit 8 would have resulted in a change of the rate of concentration decrease at PW3, sometime after the start of their operation. Figure 6 shows that the establishment of operations at ISV Unit 5 in 1988 had no discernible effect on the log-linear rate of chloroform concentration decline at PW3, which began in early 1987 and continued without change through mid-1992.

Moreover, Figure 6 shows the rate of chloroform concentration decline in PW3 was lower after startup of ISV Unit 8 in November 1992. A later decline of chloroform concentrations in PW3 coincided with the May 1995 start up of pumping at PW13. ISV Unit 8 has also been ineffective at preventing chloroform from migrating into the LBA from portions of the SGZ within its area of influence. Groundwater having relatively high chloroform concentrations reached the LBA from Source Area 5, bypassing capture by ISV Unit 8 (Figures 3 and 4). This groundwater was previously captured by PW3, but since early 1995 has been captured by PW13, which is apparent from the rise of chloroform concentrations in LF-1.

UBA
LBA
Vent

Groundwater sampling of non-CM wells in 1997 indicates that ISV Unit 5 operations also have not measurably affected chloroform concentrations in groundwater of the SGZ. Sampling of groundwater from Vent C4 in ISV Unit 5 shows that chloroform concentrations in the SGZ directly beneath Unit 5 are the same as they were when sampled in 1991 (Figure 8). Therefore, the full benefit of chloroform concentration reduction in SGZ groundwater by ISV Unit 5 was realized in the first few years of its operation.

The very nature of the geologic formations which underlie the WP site restricts the reach of the ISV Units and renders these systems technically impracticable. The upper bedrock aquifer (UBA) is a relatively tight, saturated zone, that occurs at the bottom of the SGZ, above the LBA. Immiscible chloroform must pass through the UBA in order to migrate to the LBA. The relatively poor hydraulic conductivity and connectivity of fractures in the UBA inhibits the downward rate of contaminant transfer from the UBA to the LBA. Since the rate of contaminant mass transfer from the UBA to the LBA is less than the rate of contaminant mass extraction by production wells in the LBA, this has caused a steady decrease in contaminant concentrations in the LBA. The fact that this has occurred at the West Point Site is well established and documented in previous reports (*Corrective Measures Study, Phase III Report for the Hydrogeologic Investigation at the West Point Site*, Nittany Geoscience, July 1993).

4.0 SHALLOW GROUNDWATER SYSTEM

The shallow groundwater treatment unit treats groundwater from the SGZ that is collected from sumps at Buildings 45 and 78 and two vents at ISV Unit 5. Contaminants are removed through GAC filtration. The system was installed to improve ISV operation by dewatering the shallow groundwater zone and removing water entrained in the influent vapor stream. At a later time, two building foundation drain sumps were piped to the system for carbon filtration prior to discharge to the POTW. The shallow groundwater treatment system is auxiliary to a CM (ISV Unit 5), but is not otherwise required as part of the remedy.

Shallow groundwater is collected for treatment from ISV vents C4 and C7, and from groundwater collection sumps NSSX (Building 45 foundation drain) and NSS2A (Building 78 foundation drain). Vents C4 and C7 collect groundwater from bedrock above a depth of 100 feet bgs. These wells were selected to dewater the

SGZ and improve ISV Unit 5 operation by reducing the amount of water entrained in the ISV vapor streams. The building sumps collect groundwater migrating from the soil and weathered bedrock to the more conductive trench fill material; they are installed just below the soil-bedrock interface at a depth of approximately 15 feet. During the past two years, the average flow from the shallow groundwater recovery system was approximately 5000 gallons per day. The contribution from the Buildings 45 and 78 sumps averaged approximately 1700 gallons per day, and varied from several hundred to about 5000 gallons per day. Flows from the ISV vents ranged from zero to 2600 gallons per day from vent C4 and from zero to 1400 gallons per day from vent C7.

As described in Section 3.3, ISV Units 5 and 8 are not effective systems for the attainment of remedial goals set at the West Point Site. Therefore, pending EPA approval of the closure of ISV Unit 5, ISV vents C4 and C7 will be abandoned and groundwater will no longer be collected from these wells. However, the shallow groundwater treatment system will continue to operate and remove VOCs from groundwater collected from the Building 45 and Building 78 foundation drains.

5.0 GROUNDWATER MONITORING PROGRAM

Merck currently monitors the groundwater concentration of the 12 VOCs specified in the FDRTC to evaluate the effectiveness of the CM and for the protection of public health. These data indicate that the outer margins of the chloroform plume are in an essentially static position, which is indicative of complete containment by the pump-and-treat system. The long-term trend of declining chloroform concentrations in groundwater at the site has continued through the CMI, with localized variations resulting from the accommodation of individual productions wells to the addition of two new production wells. Quarterly sampling of residential wells provides water-quality monitoring for those well owners who rely on groundwater as a source of potable water. These sampling results indicate that all 7 residential wells remaining in the monitoring program have continued to meet compliance standards with respect to site-related constituents. Tables in Appendix C showing data reviewed from the past four years illustrate that there were no exceedances of media cleanup standards at any residential well sampled except R107, which exceeded the TCE media cleanup standard 3 times in the past two years. This well was not in use by its owner as a potable water source and was abandoned in February 1997. The quarterly TCE isoconcentration maps clearly

identify the source of the low concentrations in R107 to be unrelated to the Merck site.

5.1 Operation and Modifications

Quarterly groundwater sample collection and water level monitoring is conducted in accordance with the "Quarterly Sampling and Analysis Plan for CMI Groundwater Monitoring" (Appendix D of the CMI Work Plan). The quarterly groundwater monitoring program has been modified since the beginning of the CMI, as follows.

- North Wales Water Authority Well 23 was abandoned in September 1994, and use of Well 7 was discontinued in September 1995 and subsequently abandoned in 1997.
- Five domestic wells (R003, R026, R042, R060, and R107) specified for quarterly sampling in the FDRTC have been abandoned.

5.2 Re-evaluation of Sampling Frequency and Locations

The evaluation of the CMI groundwater monitoring program involved four analytical steps, concerning the hydrogeologic conditions of the West Point site and the past four years of sampling results from the CMI monitoring well network.

1. The first step of the evaluation was to examine the hydrogeologic setting of monitored wells. The well locations were compared to groundwater elevations and flow pathways estimated from the quarterly groundwater elevation maps.
2. The second step of the evaluation was to calculate summary statistics for the past four years of quarterly sampling results for the 15 CMI monitoring wells, 9 Merck production wells, and 10 residential wells.
3. The third step of the evaluation was to compare summary statistics for the 12 site-specific VOCs at each well to MCLs or RBCs listed in Table 2 of the FDRTC. Trend plots of chloroform and trichloroethene concentrations were prepared for each well to facilitate these comparisons.
4. The fourth step of the evaluation was to compare statistics on a parameter by parameter basis to MCLs. The objective of this analysis was to identify parameters that have consistently not been detected, or have consistently been detected at low levels relative to their MCL for at least three consecutive years. The AOC requires that monitoring continue until three consecutive years of attainment of the media cleanup standards can be demonstrated. Parameters meeting these standards are candidates for removal from the analyte list. Before

recommending the removal of any analyte, consideration was also given to whether or not increasing concentrations of a suspected break-down (daughter) product of chloroform or trichloroethene had been detected at any well.

On the basis of these four analytical steps, the following changes are recommended for the CMI groundwater monitoring program:

1. Having established a steady-state operation of pump-and-treat with no risk to receptors, groundwater monitoring is recommended to be conducted biannually (every other March) at all monitoring wells and production wells. It is important to note that weekly monitoring of the remediation system, specifically for influent, intermediate and effluent concentrations, will continue unchanged. Sampling of residential wells will continue on a quarterly basis. This will streamline the monitoring program without compromising the effectiveness of remediation or protection of human health and the environment.
2. Monitoring well N12 has been rendered redundant by the elimination of North Wales Water Authority Well 23 and should be removed from the monitoring program. With the exception of two detections of chloroform at the limit of quantification, there have been no detections of analytes at N12 in the past four years. Continued monitoring of monitoring well N13 will fulfill the role presently served by both wells.
3. Three parameters are recommended to be removed from the analyte list for all wells. These are trans-1,2-dichloroethene, vinyl chloride, and trichlorofluoromethane. Trans-1,2-dichloroethene has not been detected in any well in the past four years. Similarly, vinyl chloride has been detected only once in four years, at well N17, at a concentration of less than half its MCL of 2 µg/L. Trichlorofluoromethane has not been detected at a concentration exceeding 10 µg/L in a monitoring well or 2 µg/L in a residential well. The maximum detected result in a production well is almost 2 orders of magnitude lower than the RBC. There is no MCL for this parameter and its RBC for tap water is 1300 µg/L. Therefore, there is no health-based reason to continue monitoring for trichlorofluoromethane. Trichlorofluoromethane is not a breakdown product of chloroform or trichloroethene. Therefore, its concentration will not increase as a result of this breakdown process.

5.3 Isoconcentration and Water Level Maps

Maintenance of plume hydraulic control is demonstrated in the isoconcentration and water level maps generated quarterly as part of the CMI. Plume hydraulic control was enhanced with the addition of production wells PW12 and PW13, the abandonment of North Wales Water Authority Wells 7 and 23. Quarterly water level maps and isoconcentration maps for TCE and chloroform have been submitted

to EPA Region III with bimonthly and quarterly reports throughout Merck West Point's Corrective Action program. Pending approval, future report submittals will follow the same revised schedule as CMI monitoring.

6.0 LANDFILL MAINTENANCE

Merck has maintained the soil landfill cap as required during the past two years; there have been no instances of contact with buried waste materials. The installation of production well PW13 has improved hydraulic control in the vicinity of the landfill, as supported by evidence previously discussed in Section 2.3. As shown in Figure 3, any leachate that bypasses the landfill leachate collection system will be captured by production wells PW13 and PW1.

7.0 SITE RESTORATION

7.1 Phase III Well and Piezometer Abandonment

The Phase III Abandonment was identified in the CMI Work Plan to focus on monitoring wells that are not required for assessing the effectiveness of remediation. The Phase II abandonment was completed in 1996. The CMI Work Plan specified the following criteria for wells to be considered for Phase III abandonment.

1. Non-essential 100-foot monitoring wells – Monitoring wells identified as non-essential are wells near the 1 part per billion (ppb) contour for chloroform and TCE that are not indicated as Points of Compliance in the FDRTC. Wells used for water level monitoring are excluded from this criterion.
2. Non-detect, deep monitoring wells - Deep monitoring wells in which chloroform or TCE were never detected will be considered for abandonment.
3. Remaining piezometer nests are not included in CMI monitoring and are proposed for abandonment. These piezometers are listed in Table 2.

The December 1996 quarterly isoconcentration maps show the latest 1 ppb chloroform and TCE isoconcentration contours. On the basis of these contours and the criteria specified above, the wells listed in Table 2 are recommended for inclusion in the Phase III abandonment.

7.2 ISV Systems

Upon EPA approval to discontinue operation of ISV Units 5 and 8, the units will be closed and dismantled. All vents will be abandoned in accordance with the CMI Work Plan. These vents are listed in Table 2. All piping and equipment will be properly disposed or recycled.

7.3 Landfill Monitoring Wells

Wells LF-2 and LF-3 have been approved for abandonment by the Pennsylvania DEP and will be abandoned in accordance with methods specified in the CMI abandonment plan.

8.0 REPORTING REQUIREMENTS

8.1 Community Relations Bulletins

Merck currently manages all facets of the public-information and community-relations aspects of the CMI and publishes a yearly information bulletin in order to keep interested parties up to date on developments. Two such bulletins have been published during the CMI. Merck continues to provide bulletins to residential neighbors having wells included in the CM monitoring program.

8.2 Regulatory Agency Reporting

Merck is committed to regular reporting of CMI progress and findings to the EPA. The frequency of reporting currently coincides with the quarterly frequency of CM monitoring. Pending EPA approval of changes to monitoring frequencies, this practice will continue. Quarterly reports of reduced scope will be submitted with coverage of domestic well sampling and validation. These reports will also contain remediation system operation and maintenance information as well as mass recovery information. The results of biannual monitoring well and production well sampling will be reported with the two-year performance reports.

FIGURES

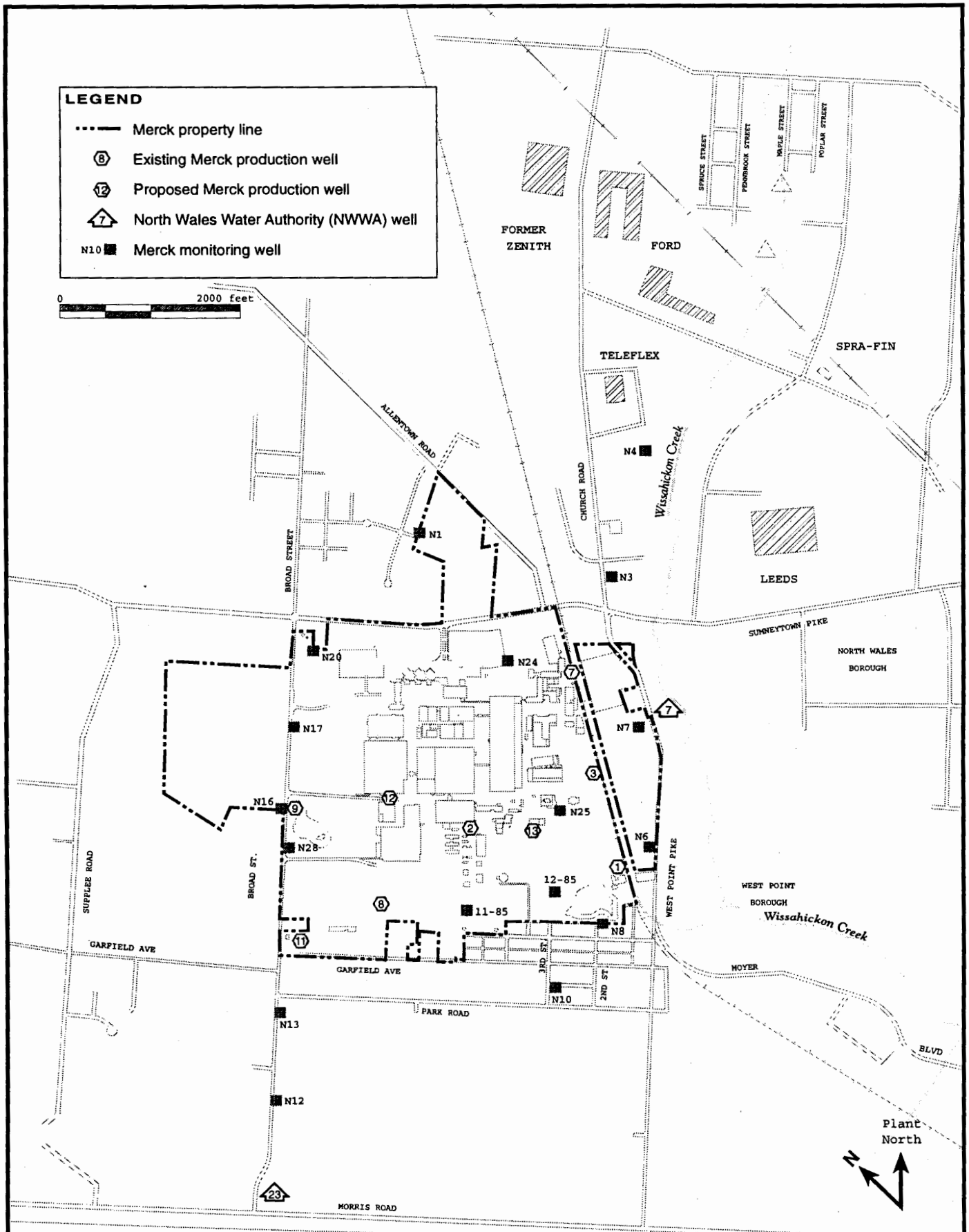

FIGURE 1
Location of Points of Compliance, Merck & Co., Inc., West Point plant site.

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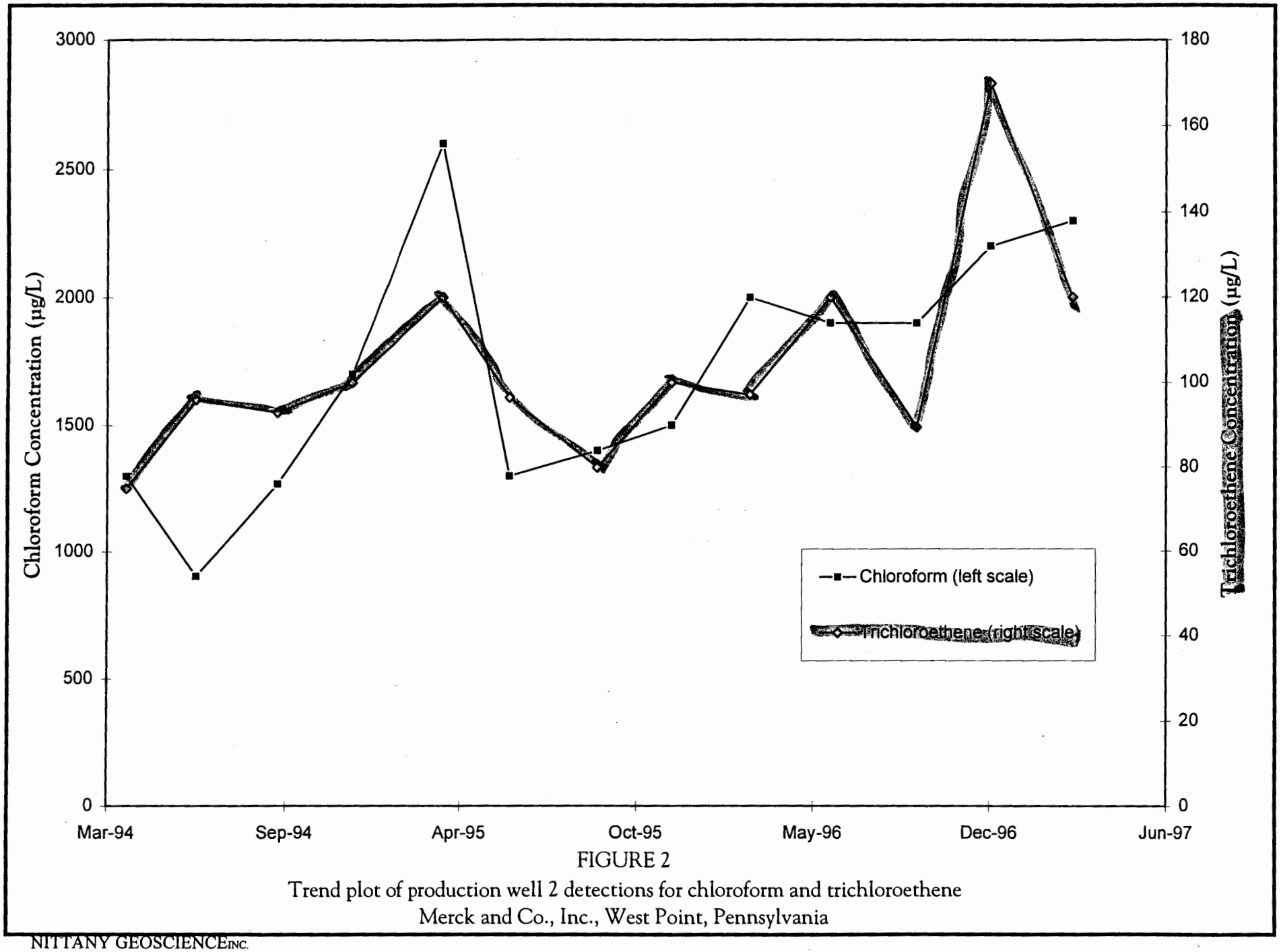
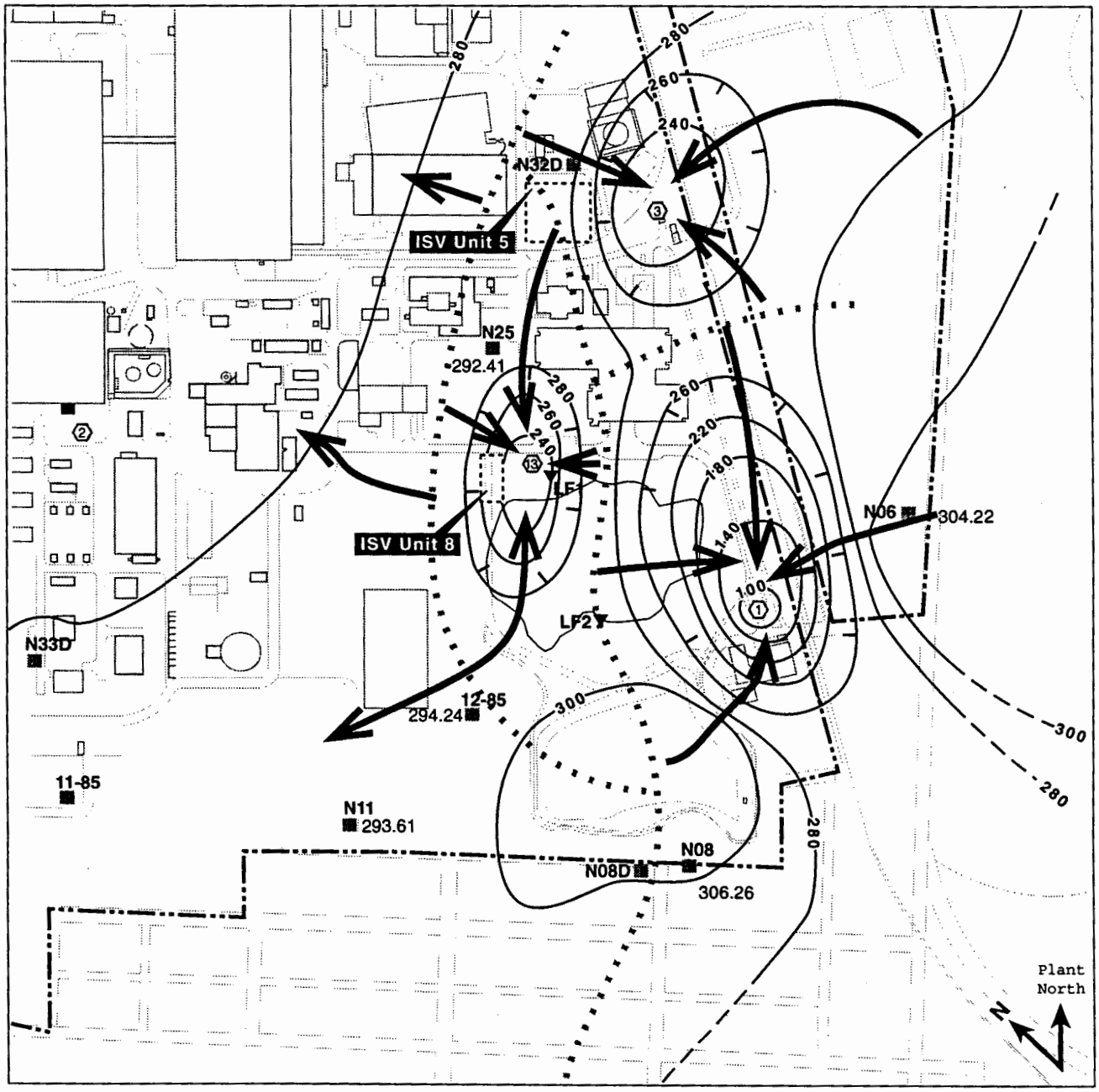


FIGURE 2

Trend plot of production well 2 detections for chloroform and trichloroethene
Merck and Co., Inc., West Point, Pennsylvania



LEGEND

- Merck property line
- ⑧ Production well
- ▼ Monitoring well for closed landfill
- N08D■ Perimeter monitoring well
- 302.93 Groundwater elevation (ft above MSL)
- -320- Groundwater elevation contour (ft above MSL)
- Direction of groundwater flow
- Groundwater divide

FIGURE 3

Map of the southeast quarter of the site showing ISV Units 5 and 8, production wells, and groundwater flow directions, Merck & Co.,Inc., West Point, Pennsylvania.

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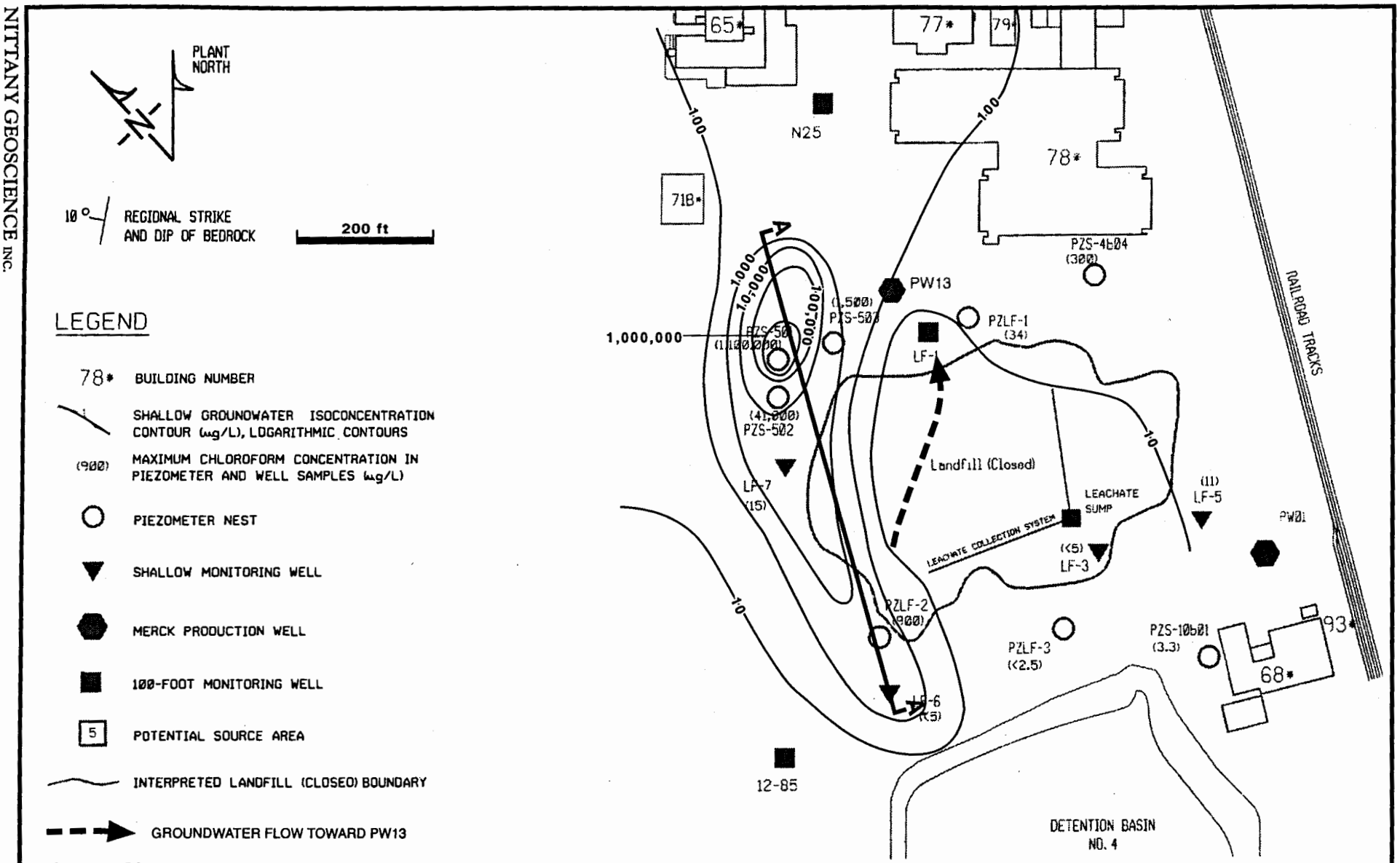

FIGURE 4

Map showing chloroform in groundwater in the vicinity of Source Area 5 and the landfill in 1992, Merck & Co., Inc., West Point, Pennsylvania.

02/005-148

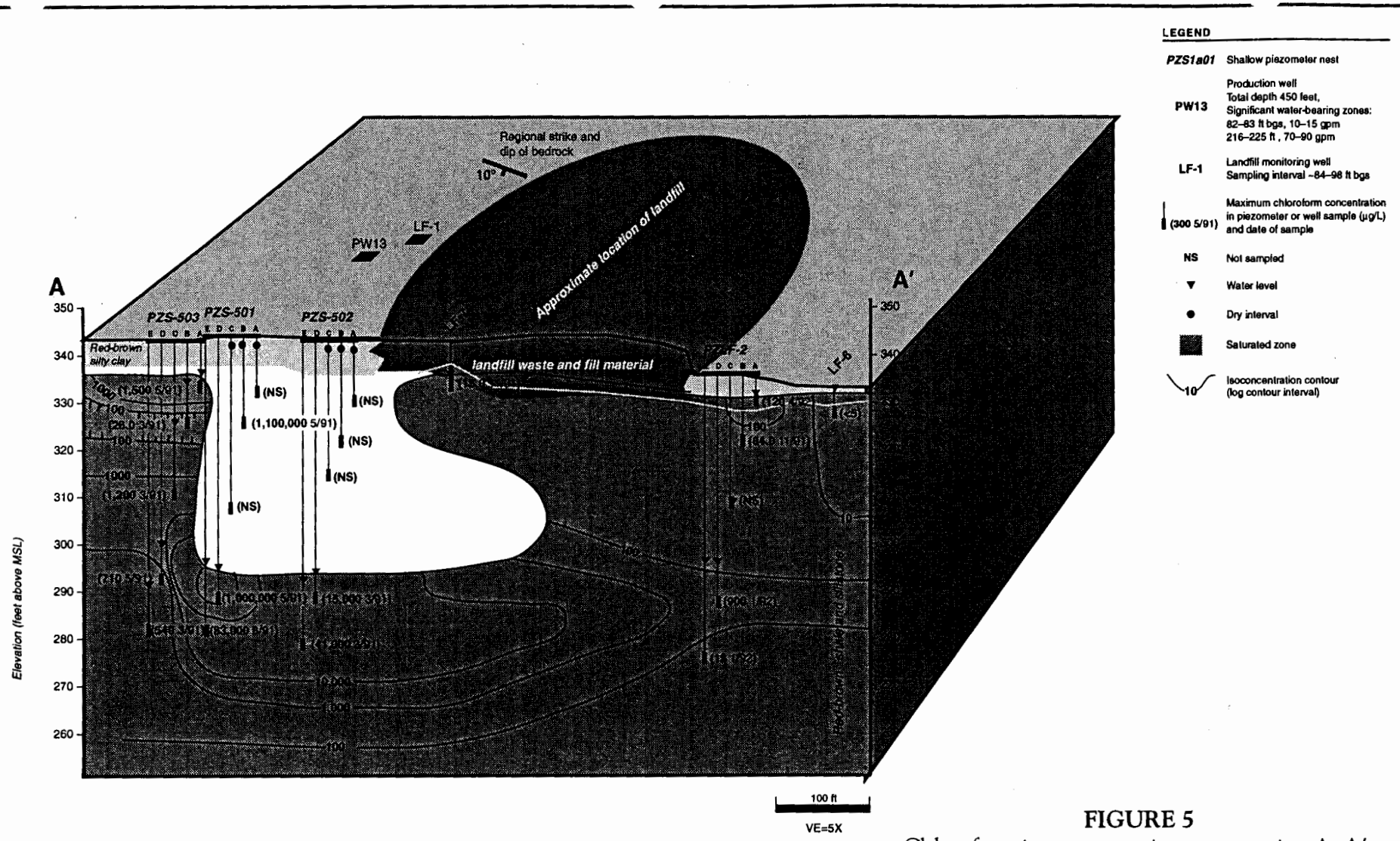

FIGURE 5
Chloroform isoconcentration cross-section A–A′,
in the vicinity of landfill,
Merck & Co., Inc., West Point, Pennsylvania.

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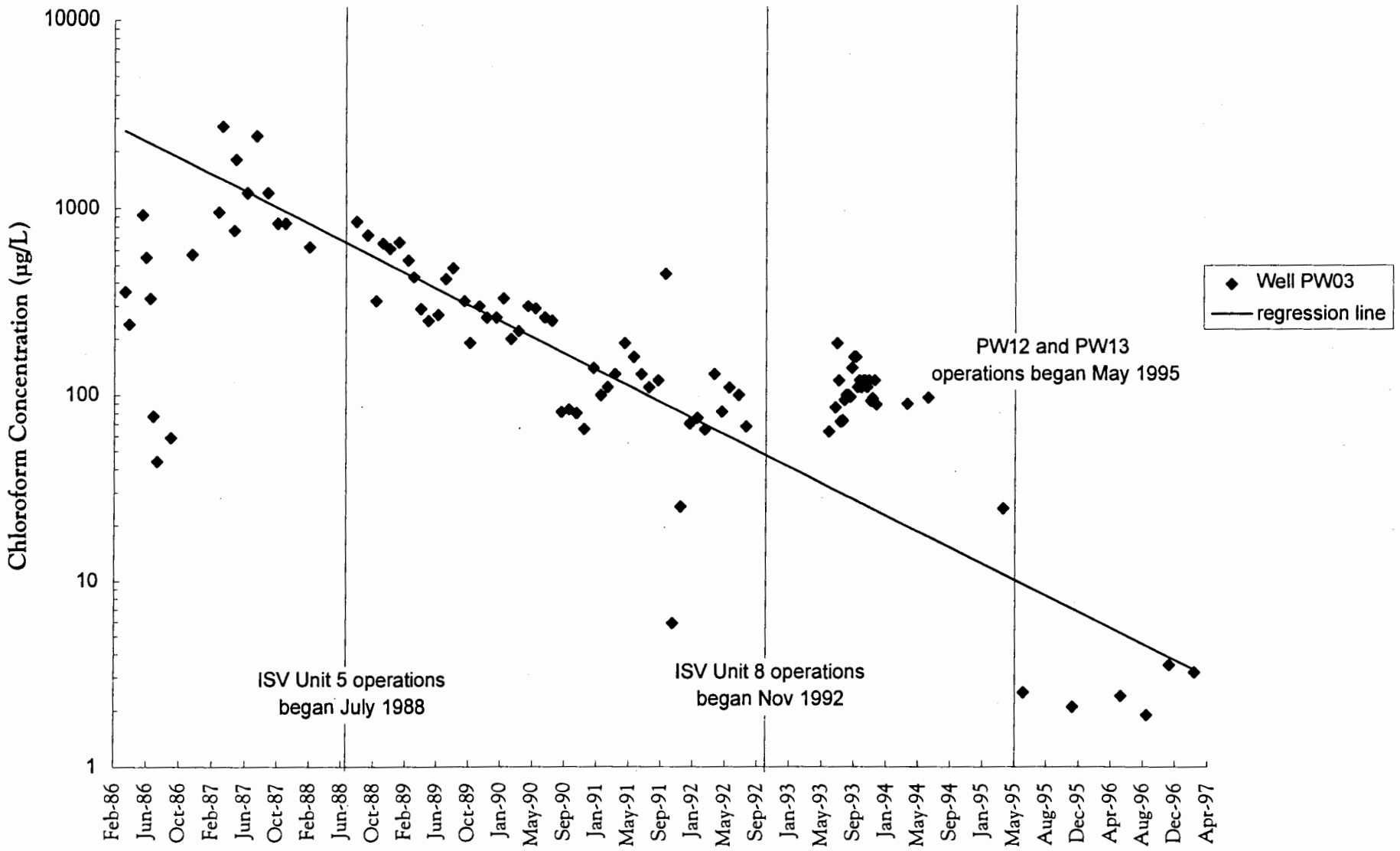

FIGURE 6

Chloroform concentrations in PW03,
during and preceding periods of ISV Units 5 and 8 operation,
Merck & Co., Inc., West Point, Pennsylvania

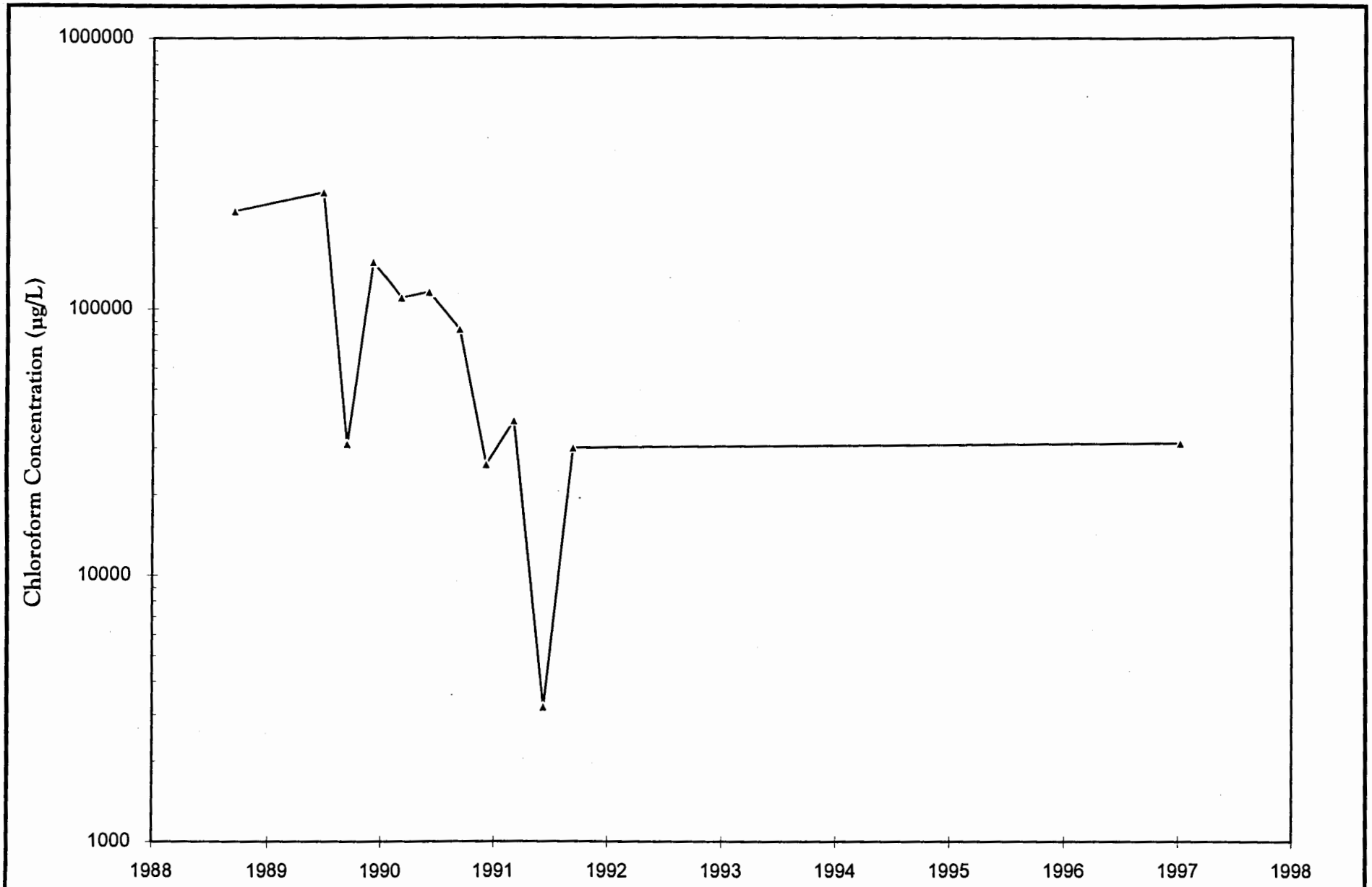

FIGURE 8

Trend plot of chloroform concentrations for Well C4,
Merck and Co., Inc., West Point, Pennsylvania

TABLES

TABLE 1
Analytical Results from Production Well Sampling
Concentration Rebound Study

Well	Sample Date	Sample	Chloroform Concentration (µg/L)	Chloroform RPC*	Trichloroethene Concentration (µg/L)	Trichloroethene RPC
PW 9	3/5/97	primary	890		<25	
		replicate	860		<25	
	3/13/97	primary	410	-54%	28	
		replicate	420	-51%	28	
	4/5/97	primary	240	-73%	27	
		replicate	240	-72%	27	
PW13	3/5/97	primary	160		<5	
		replicate	160		<5	
	3/13/97	primary	820	413%	<10	
		replicate	790	394%	<10	
	4/5/97	primary	420	163%	<10	
		replicate	530	231%	<10	
PW12	2/3/97	primary	620		110	
		replicate	650		120	
	2/11/97	primary	840	35%	180	64%
		replicate	890	37%	190	58%
	3/5/97	primary	1400	126%	230	109%
		replicate	1500	131%	240	100%
PW2	12/2/96	primary	2200		170	
		replicate	1800		140	
	12/10/96	primary	1400	-36%	108	-36%
		replicate	1300	-28%	94	-33%
	1/2/97	primary	1000	-55%	130	-24%
		replicate	1200	-33%	150	7%

Note: RPC is the relative percent change from the pre-shut-down sample or replicate
Production wells were shut down approximately 24 hours following the initial sample

TABLE 2

Monitoring Points to be Abandoned
Merck & Co., Inc., West Point, Pennsylvania

Monitoring Wells

Non-Essential 100-foot Monitoring Wells

- 12-85
- N06

Non-Detect Deep Monitoring Wells

- N08D
- N12D
- N22D

Landfill Wells

- LF-2
- LF-3

ISV Vents

- C01
- C02
- C03
- C04
- C05
- C06
- C07
- C08
- C09
- C10
- C11
- C12
- C16
- ISVPSA5-1
- ISVPSA5-2
- ISVPSA5-3
- ISVPSA5-4
- ISVPSA5-5
- ISVPSA5-6
- ISVPSA5-7
- ISVPSA5-8

Piezometer Nests

Shallow Piezometers

- PZS1B01
- PZS1B03
- PZS1C01
- PZS1C02
- PZS2A01
- PZS2A02
- PZS2A03
- PZS302
- PZS303
- PZS4A01
- PZS4A02
- PZS4A03
- PZS4B01
- PZS4B03
- PZS501
- PZS502
- PZS503
- PZS7B02
- PZS7B03
- PZS10A02
- PZS10A04